1-1-1959

Visual-aural transfer attributable to response-mediated generalization.

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LIFTON - 1959

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Thesis submitted in Partial Fulfillment of the Requirements for the Degree of Ph.D.
University of Massachusetts, Amherst

January 1959

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Introduction

Intermodal or cross-modal transfer refers to the facilitation of the learning or performance of responses to stimuli in one sensory modality which results from the prior learning or performance of those responses to stimuli in another sensory modality. Demonstrations of the occurrence of intermodal transfer have been infrequent and sporadic. Even less interest has been shown in obtaining more exact functional relationships showing the direction and degree of intermodal transfer and in more precisely specifying the possible bases of such transfer.

In the present study, the further demonstration of intermodal transfer, specifically transfer of responses from visual to aural stimuli, is presupposed by the two objectives of: (a) testing the hypothesis that response-mediated generalization plays a role in intermodal transfer, and (b) determining the effects on such transfer of strengths of associations between visual stimuli and mediating verbal responses and between aural stimuli and the same mediating responses. Prior demonstrations of intermodal transfer are summarized first, after which the hypothesis that such transfer depends on response-mediated generalization is developed. Finally, the theoretical analysis specific to the conditions of this experiment and predictions stemming from the analysis are described.

Demonstrations of Intermodal Transfer

Using rats in a maze situation, Wylie (33) obtained intermodal transfer of choice-point responses established to buzzer, light, and shock stimuli. Demonstrations of transfer of conditioned responses among visual, auditory, and tactual sensory modalities have been reported in several studies of semantic and response-mediated generalization. For example, using children as subjects, Traugott (30) conditioned approach responses to a bell and avoidance responses to a bell plus a colored light. The avoidance responses generalized from the bell plus colored light to the bell plus the spoken name for the color. Similarly, Smolenskaya (29) obtained generalization of classically conditioned responses from colored lights to spoken names for the colors. Kapustnik (10) reported that respiratory responses conditioned to aural stimuli generalized to written names for such stimuli. Those responses also generalized from aurally presented names of objects to the actual objects.

Shipley (26), in a study later verified by Lumsdaine (13), first conditioned eyelid closure to a light stimulus, after which finger withdrawal and lid closure were evoked repeatedly by shock to the finger. Subsequently, although the light had never been paired with finger withdrawal, its presentation produced that response. Transfer of finger flexion from the color green to the spoken word "green" was obtained by Rexroad (21). Jones and Batalla's (8) 11 to 14 year-old children first learned to negotiate a room-sized maze. But there was no transfer to subsequent learning of correct choices in a stylus maze of the same pattern.

Neither the stimuli and responses nor the procedures of the above cited studies resemble those employed in conventional verbal learning tasks. Apparently the first of such studies is that of H. J. Reed (20), whose stated purpose was to ascertain the effects of shifts of stimulus modality on retention of paired associates rather than to demonstrate intermodal transfer. But the number of correct responses on the recall trial indicated that visual-aural and aural-visual transfer had occurred.

Over twenty years elapsed between Reed's observation and Gaydos's (4) and Lifton's (11) demonstrations of intermodal transfer in paired-associates tasks. Gaydos worked with the visual and the tactual-kinesthetic sensory modalities and reported that acquisition of names to forms presented in one of these sensory modalities resulted in significantly more rapid learning of those names to the same forms presented in the other sensory modality. Lifton (11) presented word stimuli of high and low meaningfulness first aurally and then visually to one half of the Ss, and first visually and then aurally to the other half. The learning of verbal responses to word stimuli presented in the first modality, facilitated learning of those responses to the same word stimuli presented in the second modality.

Postman and Rosenzweig (19) were concerned with intermodal transfer based on experience with more complex tasks. After college students had varying amounts of practice writing words presented visually or aurally, the visual recognition thresholds for the words were determined by varying illumination ratios,and aural recognition thresholds for the words were determined by varying signal-to-noise ratios. Transfer from one sensory modality to the other in the form of lowered thresholds was directly related to amount of prior practice. Weisman and Crockett (31) also found that practice with nonsense words presented aurally reduced visual recognition-time thresholds for those words.

Explanatory Mechanisms of Intermodal Transfer

Although the phenomenon of intermodal transfer may be regarded as relatively well-established, the evidence supporting any explanation of the phenomenon is still unsatisfactory. McGeoch and Irion's (15, p. 312) vague proposal that such transfer is mediated by symbolic processes was investigated by Lifton (11). He hypothesized that: (a) stimuli of high meaningfulness would elicit "symbolic" responses in greater number and/or greater strength than stimuli of low meaningfulness, and (b) degree of intermodal transfer would be directly related to the number of mediating "symbolic" responses common to a given stimulus when presented in aural and visual sensory modalities. The predicted greater transfer of responses to stimuli of high than of low meaningfulness, however, was not obtained. And, even if meaningfulness had been directly related to amount of positive transfer, this finding would have been only suggestive since, unfortunately, the modus operandi of symbolic processes and of meaningfulness would have remained speculative.

Because of these difficulties in specifying and manipulating symbolic processes and meaningfulness as variables, and of determining the basis of their effects in concrete situations, it would seem desirable to turn to some less obscure and more testable mechanism. The paradigm of response-mediated generalization or the acquired equivalence of cues (2,7,13,16,24) appears to be a mechanism which will both account for demonstrations of intermodal transfer and lead to new functional or parametric investigations of the phenomenon.

A response-mediated generalization account of demonstrations of intermodal transfer with human Ss assumes the following sequence of experiences: (a) pre-experimental learning, whereby a given word whether presented visually or aurally comes to evoke the same or similar response; (b) learning of a new response to the word presented in one of the stimulus modalities, but where the actual stimulus patterns to-be-conditioned consist of the stimulus word in combination with stimuli produced by the response previously established to the word; and (c) relearning, during which presentation of the same word in the second stimulus modality again evokes response-produced stimuli, but now those stimuli are already conditioned to the to-be-learned response. Because shifts in modality would result in some changes in stimulus patterns conditioned to responses, one trial relearning would be unlikely except, perhaps, with highly over-learned associations between mediating response-produced stimuli and responses.

Rather than assume the existence of this sequence of experiences, the requisite experiences could be established experimentally. Such a more direct approach would involve building-in the required common responses to paired stimuli in two stimulus modalities and then ascertaining whether a second response trained to one of the stimuli of each pair in one modality would generalize to their paired stimuli in the other modality.

This procedure for experimentally establishing the basis of <u>inter</u>modal response-mediated generalization of the responses of paired-associates and other more complex human learning tasks has already been used in several studies of the role of mediating verbal responses in <u>intra</u>modal generalization. For example, the children of Birge's (2) experiment first learned names for pairs of visual stimuli, after which a manipulative response was learned to one stimulus of each pair. In the last phase, the manipulative response generalized significantly to the second stimulus of each pair although it had never been paired with that stimulus.

Jeffrey (7) and Shepard (24,25) also report that prior acquisition of common verbal responses to dissimilar stimuli in the same sense modality resulted in positive transfer of manipulative responses. The effects on response-mediated transfer of motor responses of retroactive inhibition and suppression of common nonsense-syllable names for pairs of figures was investigated by Murdock (16). Even though retroactive inhibition and suppression of the common names did occur, the residual strength of the names was sufficient to facilitate button pushing.

Reynolds (22) was the first to undertake a direct test of the hypothesis of response mediation of <u>inter</u>modal transfer of responses of more complex human learning tasks. His <u>S</u>s were mentally deficient children who first learned a common nonsense syllable response to pairs of stimuli consisting of a visual nonsense form and an aurally presented nonsense syllable. Learning to select a different lever for the visual member of each pair followed. In the subsequent test of transfer of lever-selection to the aural stimulus of each pair, the group with the built-in associations between aural stimuli and mediating responses and between mediating stimuli and lever selections was superior to the groups without such associations. But, while in the predicted direction, the extent of facilitation was not significant statistically.

<u>Objectives</u>

Reynolds' mentally deficient children were probably less likely to use mediating verbal responses than <u>S</u>s of normal or above normal verbal sophistication. Because his results were in the predicted direction, despite the possible handicap of the type of <u>S</u>s, it seemed desirable to try to demonstrate the role of response-mediated generalization in intermodal transfer this time with more intelligent <u>S</u>s.

The first objective of this study was, therefore, to try to obtain more conclusive support for the hypothesis of response-mediated generalization of manipulative responses from stimuli presented visually to stimuli presented aurally. The second objective was to ascertain amounts of such facilitation as functions of strengths of the associations between visual stimuli and mediating verbal responses, and as functions of strengths of the associations between paired or corresponding aural stimuli and the same verbal responses.

<u>Theoretical Analysis</u>.--The basic design for the demonstration of response-mediated intermodal transfer is shown in Table 1. Requisite associations necessary to the mechanism of response-mediated generalization are established in the first three steps, and these associations serve as the hypothesized bases for intermodal transfer of lever-pushing responses to aural stimuli during the fourth step.

Table 1

Basic Design for Tests of Visual-Aural Transfer Attributable to Experimentally-Established Response-Mediated Generalization

Condition	Steps			
	1	2	3	4
Experimental (E): Response-Mediated Generalization	Learn vowel responses to visual stimuli to specific criterion	Learn same responses as used in Step I to aural stimuli to specific criterion	Learn lever pushing responses to visual and verbal-produced stimulus compounds to criterion	Learn lever pushing responses to aural and verbal response-produced stimulus compounds
Control I (CI): Acquired Distinctiveness of Cues	Learn vowel responses to visual stimuli dissimilar to those of Step I of E	Same as E	Procedure same as E. Because of dissimilarity of visual stimuli to those of Step I for this condition, no occurrence of vowel responses	Same as E
Control II (CII): Learning-Performance Sets	Same as CI	Learn same responses as used in Step I to aural stimuli dissimilar to those for E in this step	Same as CI	Procedure same as E, but no occurrence verbal response-produced stimuli

More specifically, the experimental condition, Condition _E_, is designed to assure that: (a) a common verbal response is conditioned to both members of three visual-aural stimulus pairs during the first two steps, and (b) a lever-pushing response is conditioned in the third step to the visual stimulus of each of these pairs and the stimulus produced by the verbal response it evokes. In the fourth step, a given lever-pushing response is learned to a stimulus pattern made up of an aural stimulus in combination with the stimulus produced by its verbal response. Because of the pre-established association between the stimulus produced by the verbal response and one of the lever-pushing responses, facilitation of the learning of the discriminative lever-pushing response to that aural stimulus is expected.

Under Condition _E_, as noted, the aural stimuli to which lever-pushing responses are being learned in the fourth step are the same as those to which the verbal responses had been learned in the second step. Were the aural stimuli highly or even somewhat similar, the stimuli produced by the dissimilar vowel responses might increase the distinctiveness of stimulus patterns made up of the aural and verbal response-produced stimuli. The greater distinctiveness of these patterns alone might account for any facilitation of the learning of the discriminative lever-pushing responses; such facilitation would not depend on pre-established associations between verbal response-produced stimuli and lever pushing. In order to provide a baseline for acquired distinctiveness of cues (28), and, thus, to determine the amount of facilitation due to response-mediated generalization, the first control condition, Condition _CI_, was introduced. In this condition, only associations between aural stimuli and verbal responses are established prior to learning discriminative lever-pushing responses to those stimuli.

The experiences of the first three steps are also expected to result in learning-performance sets which might be nonspecific sources of positive transfer from those experiences to the acquisition of lever-pushing responses to the aural stimuli. The second control condition, Condition _CII_, provides for learning-performance experiences comparable to those of Conditions _E_ and _CI_. By using aural stimuli during the fourth step which are dissimilar to those of the second step, associations between aural stimuli and verbal responses would be eliminated, thus leaving only learning-performance sets as possible sources of positive transfer. Since Condition _CII_ would reflect any facilitative effects of learning-performance sets, this condition serves as a baseline for such effects and for determining the degree to which performance under Condition _CI_ might be aided by the acquired distinctiveness of cues.

Fig. 1 is a diagrammatic representation and elaboration of the relationships presumed in Table 1. For the first step, $\underline{V}_1$, $\underline{V}_2$, and $\underline{V}_3$ are the visual stimuli for Condition _E_;

	STEP 1	STEP 2	STEP 3	STEP 4
	$\underline{V}_1$- - - - - - - - R_{v_1}	$\underline{A}_1$- - - - - - - - R_{v_1}	$\underline{V}_1$- - - - - - - - R_{p_1} (r_{v_1} s_{v_1})	$\underline{A}_1$- - - - - - - - R_{p_1} (rV_1 sV_1)
$\underline{E}$	$\underline{V}_2$- - - - - - - - R_{v_2}	$\underline{A}_2$- - - - - - - - R_{v_2}	$\underline{V}_2$- - - - - - - - R_{p_2} (r_{v_2} s_{v_2})	$\underline{A}_2$- - - - - - - - R_{p_2} (rV_2 sV_2)
	$\underline{V}_3$- - - - - - - - R_{v_3}	$\underline{A}_3$- - - - - - - - R_{v_3}	$\underline{V}_3$- - - - - - - - R_{p_3} (r_{v_3} s_{v_3})	$\underline{A}_3$- - - - - - - - R_{p_3} (rV_3 sV_3)
	$\underline{V}'_1$ - - - - - - - R_{v_1}	$\underline{A}_1$- - - - - - - - R_{v_1}	$\underline{V}_1$- - - - - - - - R_{p_1}	$\underline{A}_1$- - - - - - - - R_{p_1} (rV'_1 sV'_1)
$\underline{C}I$	$\underline{V}'_2$ - - - - - - - R_{v_2}	$\underline{A}_2$- - - - - - - - R_{v_2}	$\underline{V}_2$- - - - - - - - R_{p_2}	$\underline{A}_2$- - - - - - - - R_{p_2} (rV'_2 sV'_2)
	$\underline{V}'_3$ - - - - - - - R_{v_3}	$\underline{A}_3$- - - - - - - - R_{v_3}	$\underline{V}_3$- - - - - - - - R_{p_3}	$\underline{A}_3$- - - - - - - - R_{p_3} (rV'_3 sV'_3)
	$\underline{V}'_1$ - - - - - - - R_{v_1}	$\underline{A}'_1$ - - - - - - - R_{v_1}	$\underline{V}_1$- - - - - - - - R_{p_1}	$\underline{A}_1$- - - - - - - - R_{p_1}
$\underline{C}II$	$\underline{V}'_2$ - - - - - - - R_{v_2}	$\underline{A}'_2$ - - - - - - - R_{v_2}	$\underline{V}_2$- - - - - - - - R_{p_2}	$\underline{A}_2$- - - - - - - - R_{p_2}
	$\underline{V}'_3$ - - - - - - - R_{v_3}	$\underline{A}'_3$ - - - - - - - R_{v_3}	$\underline{V}_3$- - - - - - - - R_{p_3}	$\underline{A}_3$- - - - - - - - R_{p_3}
	Visual stimuli-vowel responses	Aural stimuli-vowel responses	Visual stimuli-lever responses	Aural stimuli-lever responses

Fig. 1. Schematic representation and elaboration of the sequence of training outlined in Table 1. $\underline{V}_1$, $\underline{V}_2$, $\underline{V}_3$ and $\underline{V}'_1$, $\underline{V}'_2$, $\underline{V}'_3$ are the two sets of visual stimuli; $\underline{A}_1$, $\underline{A}_2$, $\underline{A}_3$ and $\underline{A}'_1$, $\underline{A}'_2$, $\underline{A}'_3$ are the two sets of aural stimuli. The three vowel responses are R_{v_1}, R_{v_2}, R_{v_3} and the three lever-pushing responses are R_{p_1}, R_{p_2}, R_{p_3}. Associations which are to be established in a given step are indicated by broken lines; solid lines indicate those established in a prior step.

a second, dissimilar set of visual stimuli ($\underline{V}'_1$, $\underline{V}'_2$, $\underline{V}'_3$) is used with Conditions CI and CII. One of three vowel responses (R_{v1}, R_{v2}, R_{v3}) is conditioned to each stimulus of the former and of the latter set.

For the second step, $\underline{A}_1$, $\underline{A}_2$, and $\underline{A}_3$ are the aural stimuli for Conditions E and CI; $\underline{A}'_1$, $\underline{A}'_2$, and $\underline{A}'_3$ are the stimuli for CII. One of the vowel responses is conditioned to each stimulus of a set. Thus, at the termination of this step each vowel response would be conditioned to a visual stimulus and an aural stimulus for each of the three conditions.

$\underline{V}_1$, $\underline{V}_2$, and $\underline{V}_3$ are the third-step stimuli for all three conditions; one of three lever-pushing responses (R_{p1}, R_{p2}, R_{p3}) is conditioned to each. For Condition E, it is assumed that $\underline{V}_1$, $\underline{V}_2$, and $\underline{V}_3$ would each evoke the vowel response which had been conditioned to it in the first step. Thus, each lever-pushing response is presumably conditioned to both a visual stimulus and a correlated stimulus produced by the vowel response it elicits. The broken lines indicate the associations of visual and verbal response-produced stimuli with R_{p1}, R_{p2}, and R_{p3} which are presumably established in this step.

For CI and CII, the visual stimuli of the third step are different from those of the first step, and so would not elicit the vowel responses of the first step. Accordingly, because no stimuli produced by those responses would be present, lever pushing could not be conditioned to them.

A different vowel response has been conditioned to each of the fourth-step aural stimuli for Condition E during the second step. In turn, during the third step, a different lever-pushing response has presumably been conditioned to each of the stimuli produced by those vowel responses. Because of these pre-established associations between aural stimuli and vowel responses and between verbal response-produced stimuli and lever pushing, each aural stimulus is expected to be followed by pushing a different lever even though those responses have not been directly conditioned to those stimuli. Moreover, because of this initial advantage, further strengthening of associations between aural stimuli and lever pushing is expected to occur more rapidly with Condition E than with CI or CII.

The second-step and fourth-step aural stimuli for CI are also the same. Because the vowel responses have not been conditioned to the visual stimuli of the third step, lever pushing would not be conditioned to stimuli produced by those responses. During the fourth step, therefore, Condition CI could not benefit from pre-established associations between verbal response-produced stimuli and lever pushing. However, the aural stimuli are expected to elicit the vowel responses which have been conditioned to them during the second step. Should the distinctiveness of the aural stimuli be enhanced by the stimuli produced by the vowel responses, some facilitation of acquisition of lever pushing would be expected. Thus _CI_ controls for any facilitation obtained with Condition _E_ which might be attributed to acquired distinctiveness of cues, and any superiority of _E_ to _CI_ would be attributed to associations between verbal response-produced stimuli and lever pushing.

The fourth-step aural stimuli for _CII_ are different from those of the second step; the visual stimuli for the first and third steps are also different. Since neither pre-established associative chains nor acquired distinctiveness of cues are available to facilitate acquisition of lever pushing, this condition controls for any facilitative effects arising from factors other than response mediation and acquired distinctiveness. And any superiority of _CI_ to _CII_ would, therefore, be attributed to acquired distinctiveness.

Predictions.--The strengths of associations between verbal response-produced stimuli and lever pushing established during the third step would be, in part, a function of the number of times those stimuli were available for lever pushing to be conditioned to them. In turn, availability of those stimuli would be a direct function of the strengths of associations between the visual stimuli and vowel responses.

The strengths of associations between aural stimuli and vowel responses would, in turn, be directly related to frequencies with which verbal response-produced stimuli occurred during the fourth step and were present to elicit the lever-pushing responses to which they had been conditioned in the third step. As a consequence, amount of transfer of lever pushing from visual to aural stimuli was expected to vary directly with strengths of associations between visual stimuli and vowel responses and between aural stimuli and vowel responses.

Associations between visual stimuli and verbal responses were strengthened to low or high levels and associations between aural stimuli were also strengthened to low or high levels. Thus, within each of the three conditions there were four combinations of strengths of associations. The largest amount of intermodal transfer was predicted for the combination of high strengths of associations between visual stimuli and verbal responses, and between aural stimuli and those responses. The combination of low strengths of associations of verbal responses to visual and to aural stimuli was expected to produce the least positive transfer. For the two combinations involving high strengths of associations in one step and low strengths of associations in the other, however, present empirical data and theoretical formulations were not sufficiently well developed to generate a prediction any more precise than that they would produce intermediate amounts of transfer. Because of the additional facilitation arising from the associations between verbal response-produced stimuli and lever pushing, each of the four combinations of strengths for the _E_ condition was expected to show greater transfer than the corresponding combination for Condition _CI_.

For Condition _CI_, any acquired distinctiveness of the aural stimuli arising from verbal response-produced stimuli during the fourth step would presumably be directly related to the low and high strengths of associations between aural stimuli and vowel responses established during the second step. The strengths of those associations were expected to be directly related to any positive transfer obtained with _CI_.

For Condition _CII_, because the visual stimuli of steps one and three were different, as were the aural stimuli of steps two and four, it was predicted that strengths of associations established in the first two steps would not influence rate of acquisition of lever pushing during the fourth step. Further, those combinations were expected to learn the fourth-step task more slowly than the _CI_ combinations.

Method

Subjects

The _S_s were 144 women at the University of Massachusetts. Seventy-two were drawn from the introductory psychology course and 72 were volunteers. They were randomly assigned to one of 12 groups of 12 _S_s each, within the restriction of equal numbers of introductory psychology and volunteer _S_s in each group. None had any prior experiences with Morse code.

Stimuli and Responses

In order to obtain the two sets of three visual stimuli each, 20 forms were first constructed by the method described by Attneave and Arnoult (1). For the construction of each of these forms, 10 pairs of numbers were selected randomly to serve as coordinate points. These points were plotted on graph paper and then connected randomly within the restriction that no point be incorporated into the body of the form by connections between other points.

Following Mandler (14), the meaningfulness (_m_) or associative frequency of these stimuli was specified by the mean number of associations written for each form by 26 _S_s in a 30-sec. period. Each of the six stimuli used had an _m_ of 1.5 or less. To obtain dissimilar forms, 17 different _S_s each selected four groups of three dissimilar forms from the

20 initial forms. After cross-tabulating these dissimilarity groupings, two sets of three forms each were selected; within each set the forms were highly dissimilar. Thus, the forms of the two sets, V and V', were of low meaningfulness and of low similarity to each other.

The aural stimuli were Morse code signals which are among those least likely to be confused with each other (23). Their meaningfulness was also specified by Mandler's technique and criterion. To do so, each signal was presented by means of a tape recorder on which each occurred repeatedly through the 30 sec.-interval in which Ss wrote their associations. The m values for the six signals were all less than .30. These stimuli were then divided randomly into two sets, A and A', of three each.

The verbal responses were saying the vowels "e" as in beet, "o" as in low, and "u" as in boot. These responses were selected because, being highly practiced, Ss would not have to learn how to say them correctly while also learning the correct associations. With respect to tongue placements and lip movements they are quite dissimilar (9). The manipulative responses were pushing a lever in a horizontal response panel in three directions, each separated by 90°.

Apparatus

Visual presentation of stimuli was by means of tapes mounted on a horizontal, motor-driven belt. A Pentron tape recorder (Model 9T3c) was used for aural presentation.

A horizontal panel with a vertical protruding lever set in a universal joint was used for the manipulative responses. Three slots cut in the panel permitted movement of the lever in three directions, 90°, 180°, and 240°, where the 180° direction was directly back away from the S. Movement of the lever into the slots activated micro-switches; correct direction responses turned on a panel light located directly in front of S on the perimeter of the circle joining the termini of the three slots.

Procedure

Each of the four steps in the training of Ss in each of the three conditions is described. The procedures for counterbalancing possible effects of particular sets of visual and aural stimuli are presented in the Appendix.

Verbal responses to visual stimuli.--Under the E condition, Ss learned a different vowel response to each member of one of the two sets of three nonsense forms by the paired-associates technique. The forms alone were presented for three sec., after which the stimulus for the to-be-associated vowel sound appeared for three sec. The three pairs of form-vowel stimuli occurred in a random order, within the restriction that each pair appeared twice within each successive block of six trials each and the same pairs were not repeated on the next trial. Inter-pair intervals were three sec. The Ss were trained to either low or high levels of mastery of correct responses to the form stimuli. The criterion for the low level of mastery was five correct anticipations in a block of six trials; that for the high level was 17 correct anticipations in three successive blocks of six trials each.

The second set of three nonsense forms was used as stimuli for paired-associates learning of vowel responses under the CI and CII conditions. In all other respects, including acquisition to either low or high levels of mastery, the treatment administered to Ss of these conditions was the same as that administered to the E condition.

Verbal responses to aural stimuli.--The second step for all three conditions was the paired-associates learning of a different vowel response to each of the three members of one of the two sets of Morse code stimuli. Each code stimulus was presented at the beginning of a 3-sec. interval; at the end of that interval the stimulus for the vowel response was spoken. There was no further sound during the remainder of the 3-sec. interval in which the vowel was spoken and during the 3-sec. intertrial interval which followed. The order of presentation of the three code vowel pairs was random within the restriction that each of these pairs appeared twice within successive six-trial blocks and no pair was repeated on the next trial.

Half the Ss of Condition E who had learned the form-vowel association to the 5/6 criterion acquired the code-vowel associations to the same criterion. The other half learned the vowel responses to the code stimuli to the 17/18 level of mastery. The same was true of Ss of Condition E who had learned the form-vowel associations through 17/18 criterion. Thus, by the end of the second step there were four groups within Condition E, each of which represented one of the four combinations of low or high strengths of mastery of vowel responses to form stimuli with low or high levels of mastery of vowel responses to code stimuli.

The treatment under Condition CI during this step was identical with that administered to E. With the exception that the different vowel responses were learned to the members of the second set of Morse code stimuli, Condition CIII was treated the same way as E and CI. Thus, by the end of this step, both CI and CII also consisted of four groups, each of which represented one of the four combinations of low and high strengths of vowel responses to the form and to the code stimuli.

Manipulative responses to visual stimuli.--All four of the groups which represented the different combinations of association strengths under Conditions E, CI, and CII learned the same lever-pushing task. The lever was to be pushed in a different direction for each of three forms. Each form stimulus was presented for five sec. and S responded by pushing the lever in any one of the three directions. If the chosen direction were correct, the panel light went on to indicate to the S that the right choice or response had occurred. If the wrong response were made, the light remained off. No correction of incorrect choices was permitted. After each 5-sec. presentation interval, five seconds elapsed before the next form was presented. The forms appeared in random order subject to the restriction that each occur twice within successive blocks of six trials each and none occur twice in a row. The criterion of mastery for all four combinations under E, CI, and CII was 17 correct choices in three successive six-trial blocks.

Manipulative responses to aural stimuli.--The final step for the four combinations under E, CI, and CII consisted of 36 trials to learn to push the lever in a different direction for each of the three members of one of the sets of code stimuli. These stimuli were each presented at the beginning of successive 5-sec. intervals during which Ss were to push the lever. As before, lighting the panel light indicated correct choices and no correction of incorrect choices was permitted.

Results

The results of the first three steps are of interest primarily to ascertain whether there were any differences among groups, other than those manipulated experimentally, which might have affected acquisition of lever-pushing responses to aural stimuli during the fourth step. Analysis of the data obtained in each of these steps involved: (a) an analysis of variance to isolate any significant main or interaction effects which might have been related to fourth-step performance, and (b), in cases where significant main or interaction effects were obtained, the computation of correlations to determine whether those differences were actually related to differences in the fourth step.

Visual stimuli-vowel responses.--Means and standard deviations of numbers of trials through the 5/6 and 17/18 criteria for vowel responses to form stimuli are shown in Table 2. For each criterion, differences among Conditions *E*, *CI*, and *CII* both within and between Sets *V* and *V'* were negligible. As expected, more trials were required to complete the 17/18 than the 5/6 criterion. The analysis of variance for differences among these means is summarized in Table 3. Only the *F*'s for Association Strength and two interactions were significant.

Fig. 2 suggests that the greater number of trials through the 17/18 criterion for Condition *E* relative to *CI*

Table 2

Means and Standard Deviations of Trials through Criterion

in Step I for Vowel Responses to Visual Stimuli

Condition	High Association Strength				Low Association Strength				Total	
	Set _V_		Set _V'_		Set _V_		Set _V'_			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
_E_	33.67	11.22	36.33	10.34	10.42	1.29	12.67	5.80	23.27	14.36
_CI_	28.50	10.95	26.42	7.05	14.58	12.29	12.50	4.07	20.50	11.53
CII	31.75	10.03	28.17	5.88	10.83	2.21	12.17	3.59	20.73	11.19
Total	31.31	10.95	30.31	9.01	11.94	7.48	12.44	4.60	21.50	12.50

Table 3

Analysis of Variance of Trials through Criterion in Step I for Vowel Responses to Visual Stimuli

Source	df	Mean Square	F
Conditions (C)	2	113.52	1.92
Association Strength (AS)	1	12,469.44	210.78***
Set (S)	1	2.25	
C x AS	2	273.34	4.62*
C x S	2	68.77	1.16
AS x S	1	20.25	
C x AS x S	2	650.90	11.00***
Error (within)	132	59.16	

* Significant at .05 level

*** Significant at .001 level

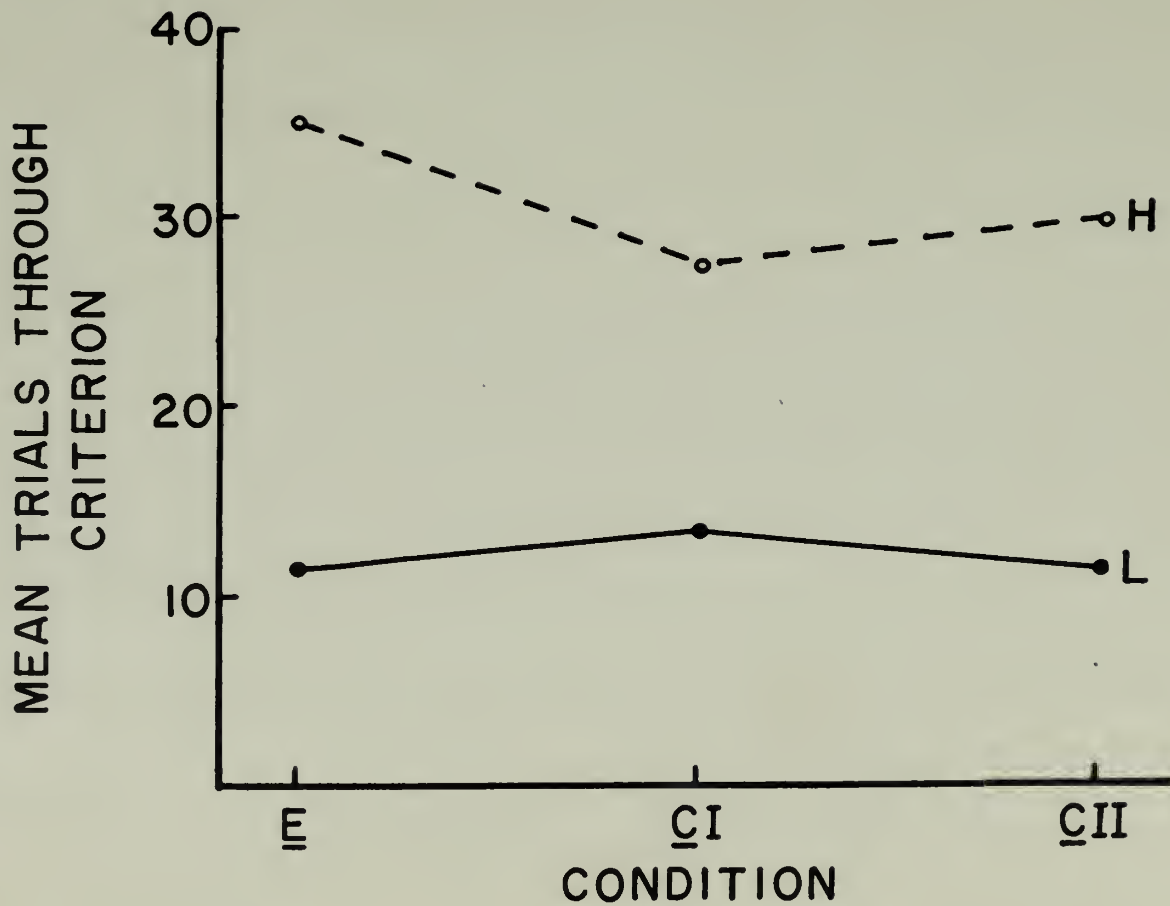

Fig. 2. Mean trials through criterion in Step I for vowel responses to visual stimuli, under Conditions E, CI, and CII for high (H) and low (L) association strengths.

and CII was the basis for the interaction of Conditions and Association Strength. Statistical confirmation of this conclusion comes from the finding that, with a difference of 4.35 between pairs of means required for significance at the .05 level, the mean of trials through the 17/18 criterion for Condition E was significantly larger than means through that criterion for CI and CII. The latter means did not differ significantly nor were there significant differences among the means through the 5/6 criterion for E, CI, and CII.

The difference between pairs of means in Fig. 3 necessary for significance at the .05 level is 6.15. None of the differences between pairs of the six means for low association strengths was significant, nor were those between pairs of means for E, CI, and CII through the 17/18 criterion with Set V. But with Set V', Condition E required significantly more trials to reach high association strength than did CI and CII. Thus, the interactions of Conditions, Association Strength, and Sets and of Conditions and Association Strength were due in large measure, if not entirely, to the greater number of trials through the 17/18 criterion for Condition E with Set V'.

The rank-order of the six combination means of trials through the 17/18 criterion for the three conditions with Sets V and V' was compared with the rank-order of means of correct responses during the fourth step for those same groups of Ss. A rho of +.15 ($p > .05$ for 4 df) was obtained.

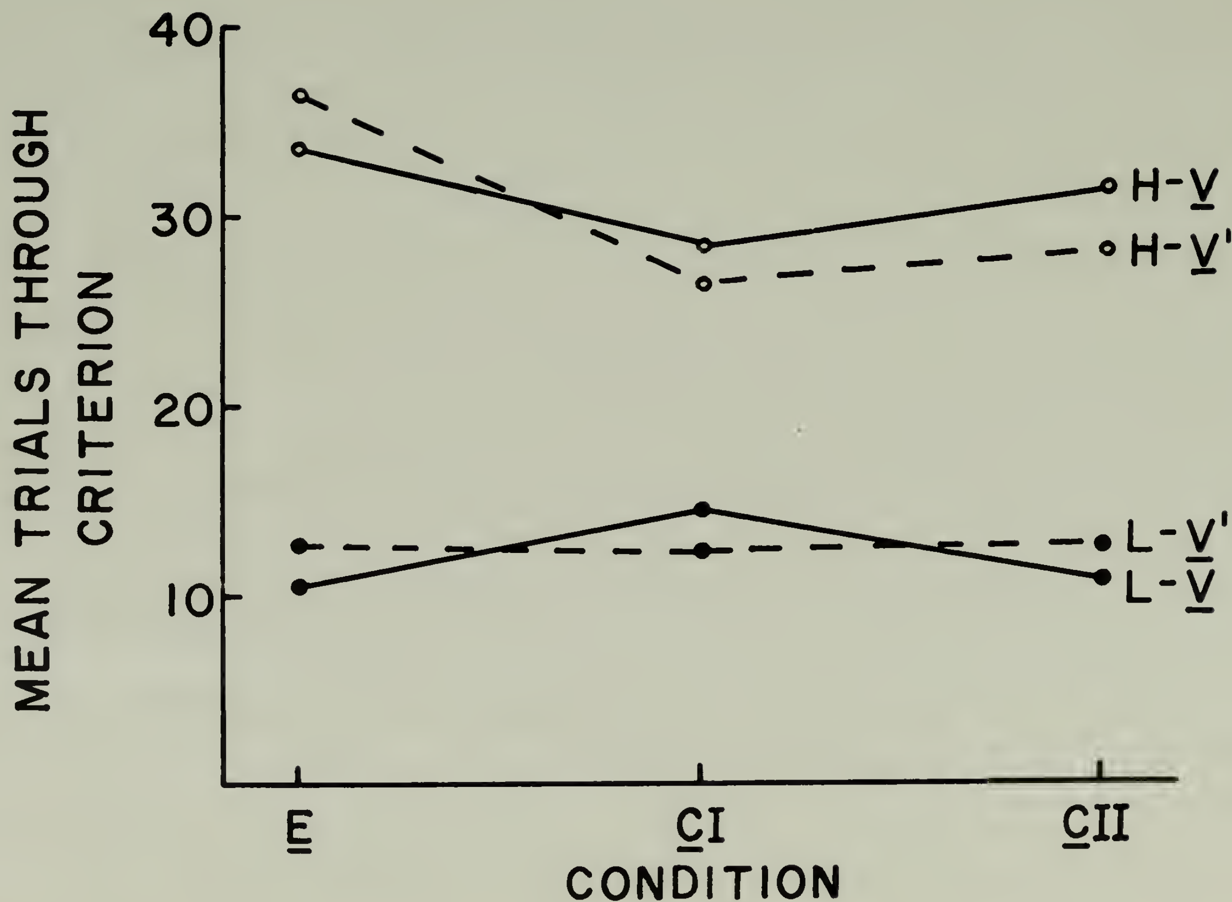

Fig. 3. Mean trials through criterion in Step I for vowel responses to visual stimuli under Conditions E, CI, and CII for high (H) and low (L) association strengths, and Sets V and V'.

Thus, differences among the means during the first step were not related to differences in fourth-step performances.

Trials through the 17/18 criterion of Ss in Condition E during the first step were compared with the correct responses of those Ss during the fourth step. Since the rho of -.30 was not significant, rates of completing the 17/18 criterion for individual Ss of Condition E were apparently not related to their fourth-step performances.

Aural stimuli-vowel responses.--The analysis of variance for differences among means of trials through criterion for verbal responses to the aural stimuli (Table 4) yielded significant F's for Association Strength and for the interaction of Conditions, Association Strength, and Sets (Table 5). Completing the 17/18 criterion required about two and one-half times the number of trials through the 5/6 criterion.

Fig. 4 suggests that the significant triple interaction was due in part to differences between Set A and Set A' with respect to rank-orders of means of trials through the 17/18 criterion under E, CI, and CII. Also contributing to this interaction were differences between rank-orders of means of trials through the 17/18 criterion with Sets A and A' on one hand and, on the other hand, rank-orders of means through the 5/6 criterion under E, CI, and CII with Sets A and A'.

The difference between pairs of these means necessary for significance at the .05 level was 27.95. With Set A',

Table 4

Analysis of Variance of Trials through Criterion in Step II for Vowel Responses to Aural Stimuli

Source	df	Mean Square	F
Conditions (C)	2	48.44	
Association Strength (AS)	1	132,435.34	108.53***
Set (S)	1	1,242.56	1.09
C x AS	2	1,059.69	
C x S	2	1,915.08	1.57
AS x S	1	82.51	
C x AS x S	2	12,824.15	10.51***
Error (within)	132	1,220.21	

*** Significant at .001 level

Table 5

Means and Standard Deviations of Trials through Criterion

in Step II for Vowel Responses to Aural Stimuli

Condition	High Association Strength				Low Association Strength				Total	
	Set A		Set A'		Set A		Set A'			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
E	82.83	33.54	109.92	54.34	33.50	37.34	22.00	8.58	62.69	48.41
CI	95.75	37.50	80.33	43.57	38.33	35.78	37.17	16.34	62.90	43.30
CII	112.50	44.57	78.67	43.30	32.75	35.24	32.33	19.07	64.06	50.03
Total	97.03	40.66	89.64	36.86	34.86	31.28	30.50	16.58	63.22	47.34

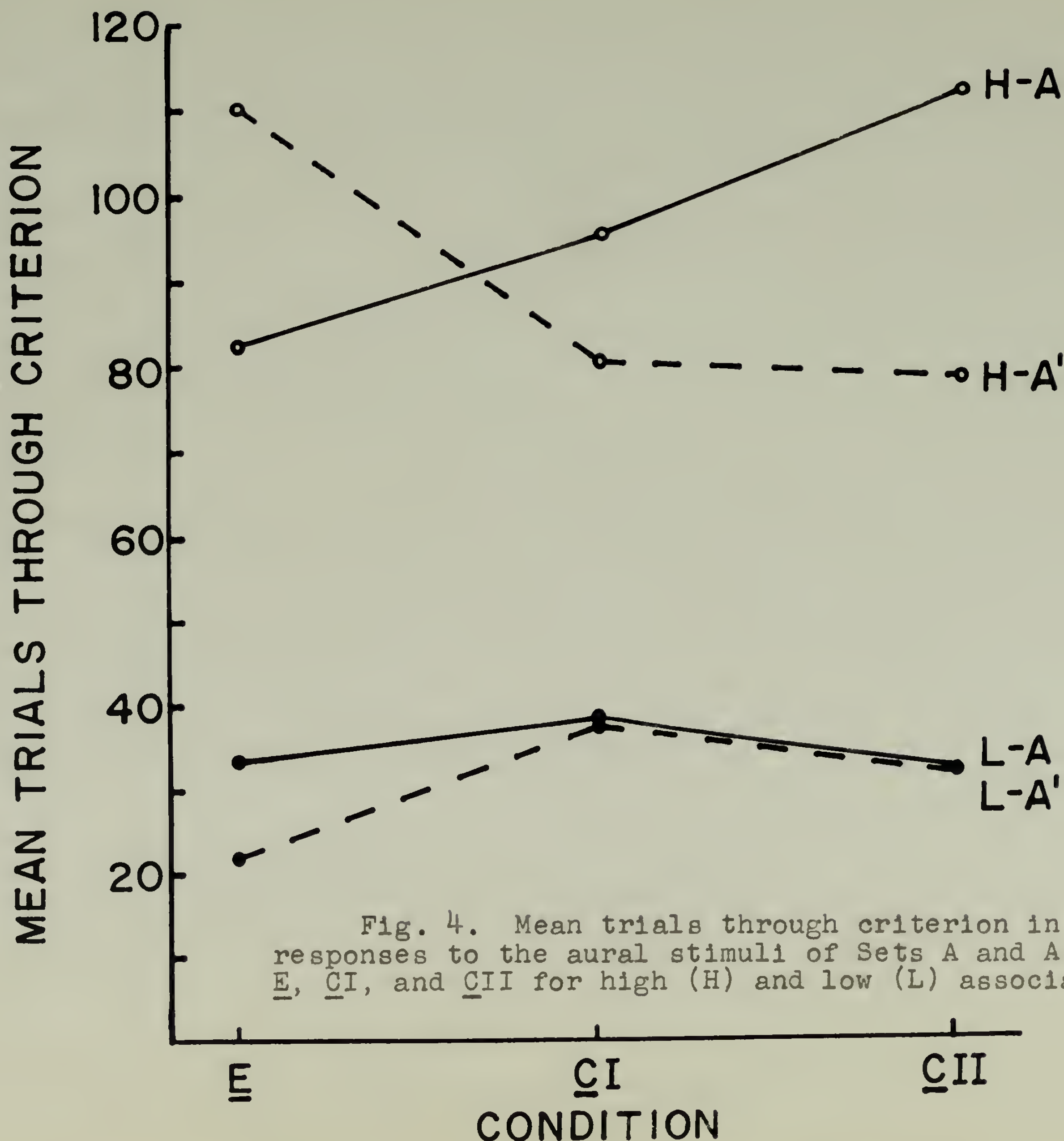

Fig. 4. Mean trials through criterion in Step II for vowel responses to the aural stimuli of Sets A and A' under Conditions E, CI, and CII for high (H) and low (L) association strengths.

the 17/18 criterion was completed significantly less rapidly under Condition E than under CI or CII. Conversely, with Set A there was faster learning under Condition E than under CI and significantly faster learning under Condition E than under CII. While the difference between Sets A and A' under Condition E was not significant, the differences between these two sets under CII was significant. None of the differences among the six means of trials to low association strength was significant. Thus, comparisons of pairs of means support the conclusion that differences between Sets A and A' in trials through the 17/18 criterion under E, CI, and CII, both with respect to each other and with respect to rank-orders for the two sets for means of trials through the 5/6 criterion, were the bases of the interaction of Conditions, Association Strength, and Sets.

The rank-order of means of trials through the 17/18 criterion for the six combinations of sets and conditions and the rank-order of the means of correct responses for those groups during the fourth step were not correlated (rho = +.04). When ranks of trials through the 17/18 criterion of Ss in each of these six combinations were compared with their performances during the fourth step, the rho's were -.06, -.07, -.13, -.19, -.37, and -.72. Although the last is significant at less than the .01 level, one rho out of six significant at this level would occur by chance 26 times in 100 (32). The learning rates of Ss in these groups for vowel responses to aural stimuli were, therefore, not related significantly to fourth-step performance.

Visual stimuli-lever pushing.--Table 6 shows means and standard deviations of trials through the 17/18 criterion for lever-pushing responses to visual stimuli for each of the four combinations of strengths of associations under Conditions E, CI, and CII. The analysis of variance, summarized in Table 7, indicates that the interaction of the three conditions with strength of associations between aural stimuli and vowel responses (Conditions x Aural) was significant at less than the .01 level. Except for the F for Conditions, which was just short of the .05 level, none of the other F's approached significance. The near-significant F for conditions was due to slightly faster learning by combinations under E and CI than by those under CII.

Fig. 5 shows the relationships of the Conditions x Aural interaction. A difference of 6.58 between pairs of these means was significant at the .05 level. There were no significant differences between means for low strengths of associations between aural stimuli and vowel responses under E, CI, and CII. But Ss of CII who had learned associations between aural stimuli and vowel responses in Step II through the 17/18 criterion required significantly more trials to learn lever-pushing responses to visual stimuli than did those of E and CI. Thus, the significant interaction was apparently due to these differences and perhaps to those

Table 6

Means and Standard Deviations of Trials through Criterion in Step III for Lever-pushing Responses to Visual Stimuli

Condition	Combinations of Association Strengths between Visual Stimuli and Vowel Responses, and Aural Stimuli and Vowel Responses								Total	
	High Visual-High Aural		High Visual-Low Aural		Low Visual-High Aural		Low Visual-Low Aural			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
E	21.08	4.14	22.25	5.86	21.83	4.78	27.58	13.25	23.19	8.31
CI	21.83	3.72	23.00	6.96	20.00	2.86	31.83	11.47	24.17	8.44
CII	34.00	26.84	24.67	8.35	30.17	14.45	24.92	8.94	28.58	21.29
Total	25.83	16.61	23.31	7.20	24.00	9.95	28.11	11.71	25.31	12.02

Table 7

Analysis of Variance of Trials through Criterion in Step III for Lever-pushing Responses to Visual Stimuli

Source	df	Mean Square	F
Conditions (C)	2	396.67	2.93
Visual Association Strength (V)	1	79.51	
Aural Association Strength (A)	1	22.56	
C x V	2	115.30	
C x A	2	656.52	4.84**
A x V	1	396.67	2.93
C x V x A	2	39.01	
Error (within)	132	135.53	

** Significant at .01 level

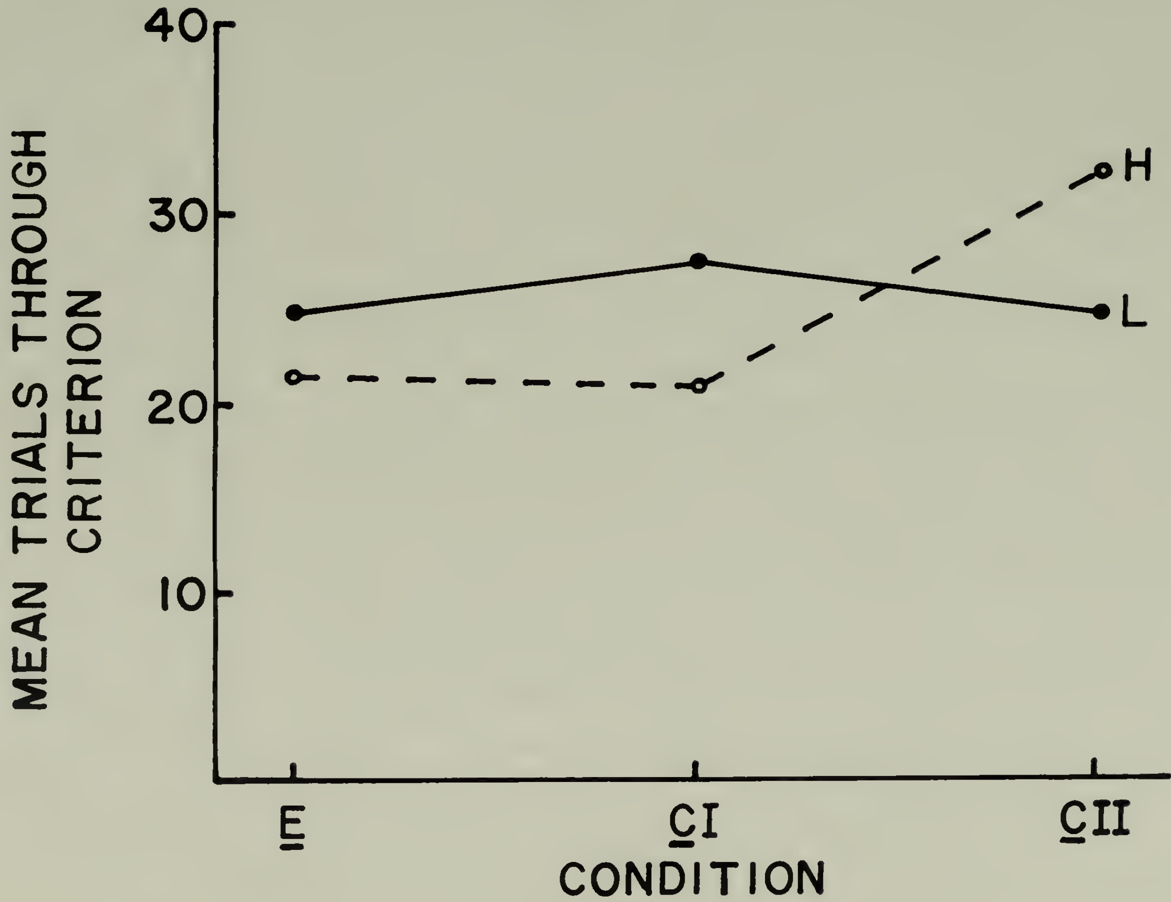

Fig. 5. Mean trials through criterion in Step III for lever-pushing responses to visual stimuli under Conditions E, CI, and CII for previously established high (H) and low (L) strengths of associations between aural stimuli and vowel responses in Step II.

between means of _CI_ and _CII_ groups which had high and low strengths of associations between aural stimuli and vowel responses in Step II.

The rho of -.55 for the rank-order of the six means entering into the Conditions x Aural interaction and the rank-order of the performance of these groups during the fourth step was not significant. Further, when the ranks of trials through criterion of _Ss_ in each of the six combinations of _E_, _CI_, and _CII_ with high and low strengths of associations between aural stimuli-vowel responses were compared with fourth-step performances, only one of six rho's was significant at the .05 level. Any differences in learning rates during the third step were, therefore, not related to fourth-step differences among groups or among individuals.

Aural stimuli-lever pushing.--The means and standard deviations of numbers of correct responses during the 36 trials of learning lever-pushing responses to aural stimuli are shown in Table 8 for each of the four combinations of strengths of association under Conditions _E_, _CI_, and _CII_. The largest numbers of correct responses were obtained with the high visual-high aural and low visual-high aural combinations under Condition _E_ and with the low visual-high aural combination under _CI_. The gap between the mean of 28.75, for the poorest of these three groups, and the mean of 25.08 for the best of the remaining nine groups, was greater than the range of 21.50 to 25.08 for the latter means.

Table 8

Means and Standard Deviations of Number of Correct Lever-pushing

Responses to Aural Stimuli in 36 Trials

Condition	Combinations of Strengths of Associations between Visual Stimuli and Vowel Responses and between Aural Stimuli and Vowel Responses								Total	
	High Visual-High Aural		High Visual-Low Aural		Low Visual-High Aural		Low Visual-Low Aural			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
_E_	28.75	6.41	23.50	7.51	29.83	4.91	24.96	5.39	26.75	6.67
_C_I	24.17	8.40	25.08	6.63	30.00	4.08	23.75	5.99	25.75	6.93
_C_II	24.50	7.48	24.58	5.87	22.67	5.96	21.50	5.29	23.31	6.34
Total	25.81	7.76	24.39	6.73	27.50	6.09	23.39	5.75	25.27	6.80

Table 9 presents means and standard deviations for each of the 12 combinations of conditions and association strengths for each of six successive six-trial blocks. The high visual-high aural and low visual-high aural combinations under Condition _E_ began at slightly higher levels than the low visual-high aural combination under _CI_. By the third block and for the remaining blocks of trials, however, means of the former two combinations were lower than the means for the latter combination. In general, until the last six trials, means for these three groups for successive blocks of trials were higher than those of the remaining nine groups.

The "Between _Ss_" sources of variance (Table 10) were conditions, strengths of associations between visual stimuli and vowel responses, strengths of associations between aural stimuli and vowel responses, and their interactions. Trials alone and in combination with the three experimental variables were the "Within _Ss_" sources.

The _F_ of 3.50 for differences among Conditions _E_, _CI_, and _CII_, disregarding combinations of association strengths, was significant at the .05 level as was the _F_ of 6.41 for strengths of associations between aural stimuli and vowel responses, disregarding conditions and strengths of associations between visual stimuli and vowel responses.

The overall means for Conditions _E_, _CI_, and _CII_ were, respectively, 26.75, 25.75, and 23.31 correct responses in

Table 9

Means and Standard Deviations of Number of Correct Responses in Successive Blocks of Six Trials

Condition	Combinations of Association Strengths*	Blocks of Trials 1		2		3		4		5		6	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
E	HV-HA	3.42	1.75	4.83	1.28	4.83	1.15	5.42	.95	5.50	1.66	4.75	1.79
	HV-LA	3.25	1.53	3.25	1.88	3.50	2.02	4.17	1.57	4.33	1.65	5.00	1.00
	LV-HA	3.50	1.61	5.00	1.00	5.00	1.67	5.25	.92	5.58	.91	5.50	.65
	LV-LA	2.75	1.61	3.58	1.32	4.67	.85	4.33	1.61	4.42	1.44	5.17	.98
	Total	3.23	1.64	4.17	1.60	4.50	1.59	4.79	1.41	4.96	1.57	5.10	1.21
CI	HV-HA	2.50	1.55	3.58	1.71	4.58	1.50	4.33	2.10	4.75	1.59	4.42	2.06
	HV-LA	3.17	2.11	3.58	2.11	4.42	1.55	4.42	1.44	4.25	1.69	5.25	.83
	LV-HA	3.08	1.94	4.75	1.16	5.17	1.07	5.50	.65	5.67	.74	5.83	.56
	LV-LA	3.17	1.62	3.00	1.47	4.08	.86	4.25	1.59	4.83	1.15	4.42	1.38
	Total	2.98	1.70	3.73	1.74	4.56	1.34	4.63	1.62	4.87	1.43	4.98	1.47
CII	HV-HA	2.92	1.65	4.42	1.55	4.58	1.38	3.92	1.32	4.25	1.53	4.42	1.80
	HV-LA	3.08	1.55	4.00	1.53	4.08	1.66	4.25	1.48	4.58	1.44	4.58	1.19
	LV-HA	2.83	1.46	3.25	1.59	3.42	1.89	4.67	1.18	4.00	1.23	4.50	1.50
	LV-LA	2.42	1.50	3.17	1.57	3.33	1.37	3.67	1.49	4.25	1.23	4.67	1.99
	Total	2.81	1.56	3.71	1.65	3.85	1.67	4.13	1.42	4.27	1.39	4.54	1.65
Total		3.01	1.64	3.87	1.68	4.31	1.57	4.51	1.51	4.70	1.50	4.87	1.47

* HV = high strength of associations between visual stimuli and vowel responses
LV = low strength of associations between visual stimuli and vowel responses
HA = high strength of associations between aural stimuli and vowel responses
LA = low strength of associations between aural stimuli and vowel responses

Table 10

Analysis of Variance of Correct Lever Responses to Aural Stimuli in Successive Six-Trial Blocks

Source	df	Mean Square	F
Conditions (C)	2	25.01	3.50*
Visual Association Strengths (V)	1	0.72	
Aural Association Strengths (A)	1	45.83	6.41*
C x V	2	12.30	1.72
C x A	2	10.34	1.45
V x A	1	10.89	1.52
C x V x A	2	7.82	1.09
Error (b)	132	7.15	
Trials (T)	5	67.66	48.57***
T x C	10	0.88	
T x V	5	1.18	
T x A	5	3.95	2.84*
T x C x V	10	1.69	1.21
T x C x A	10	1.27	
T x V x A	5	1.53	1.09
T x C x V x A	10	1.21	
Error (w)	660	1.39	

* Significant at .05 level

*** Significant at .001 level

36 trials. The difference of 1.00 between E and CI exceeded the difference of .90 required for significance at the .05 level with a one-tail test. The difference between both of these conditions and Condition CII exceeded the value of 1.27 necessary for significance at the .01 level. The overall increase in mean correct responses for successive blocks of trials was sufficient to produce a highly significant F.

High strengths of associations between aural stimuli and vowel responses established in the second step led to relatively faster acquisition of lever pushing than did low strengths of those associations; the difference in these trends was sufficient to produce a significant interaction of trials and strengths of aural associations.

Discussion

Training During the First Three Steps

Some statistically significant differences among combinations of variables other than those which were experimentally established did occur within each of the first three steps. However, correlational procedures indicated that none was related to fourth-step performances. Thus, any fourth-step differences in amount of transfer of the lever-pushing responses from the visual to the aural stimuli could be interpreted in terms of the effects or lack of effects of Conditions *E*, *CI*, and *CII*, and strengths of associations between visual stimuli and vowel responses and between aural stimuli and vowel responses.

Demonstration of the Role of Response-Mediated Generalization

Response-mediated generalization.--Disregarding combinations of strengths of associations, Condition *E* resulted in more correct lever-pushing responses than did Condition *CI*, both for all 36 trials and generally throughout the 36 trials. The superiority of *E* to *CI* was most marked during the first 12 trials. While *CI* was slightly above *E* for the third block of six trials, *E* was again superior, though to a lesser degree, during the last 18 trials. Thus, as predicted, response-mediated generalization contributes to the transfer of the responses of a relatively complex paired-associates task from stimuli in one sensory modality to stimuli in another sensory modality.

The pre-established associations between verbal response-produced stimuli and lever pushing may have given Condition _E_ an initial advantage over Condition _CI_. Even within the first few trials, however, that advantage should have begun to decrease. The reason for this decrease is that under Condition _CI_ stimuli produced by the verbal responses to the aural stimuli would soon also be conditioned to the lever-pushing responses. Further, the curves for the strengthening of associations between verbal response-produced stimuli and lever pushing are probably negatively accelerated. As a consequence, the greatest increments in the strengths of those associations, and hence the most rapid progress in Condition _CI_ overcoming the initial advantage of Condition _E_, should be in the early trials.

The acquisition curves did suggest a large initial but decreasing advantage of Condition _E_ over Condition _CI_. But in view of the failure to obtain an interaction of conditions with trials which approached significance, there is little reason to believe that the apparent difference in the trends for Condition _E_ and _CI_ was significant statistically.

Acquired distinctiveness of cues.--The consistency and high level of significance of the superiority of Condition _CI_ to _CII_ indicates that acquisition of vowel responses to the aural stimuli during the second step facilitated acquisition of lever-pushing responses to those stimuli, presumably because of increased distinctiveness of the patterns of aural and verbal response-produced stimuli.

With complex visual stimuli, some instances of positive transfer to subsequent tasks have been attributed, not to acquisition of different verbal responses to those stimuli but to prior strengthening of responses of selecting more discriminable features of the stimuli (6). In this experiment the use of aural stimuli precluded prior experience in the selection of more discriminable features as a possible source of facilitation during the fourth step.

The suggestion has also been made (6) that training designed to strengthen experimentally-introduced responses also strengthens already-established verbal responses. Any subsequent facilitation might, therefore, be ascribed wholly or in part to acquired distinctiveness based on the latter responses rather than on those which had been introduced experimentally. The low m values for the aural stimuli indicated that during a 30-sec. period they evoked virtually no pre-established responses, other than perhaps, dot-and-dash repetitions of each stimulus. With the possible exception of repetition responses, pre-experimental responses were probably not available for the further strengthening necessary for them to be effective bases for acquired distinctiveness.

Repetitions of the aural stimuli might have been another source of acquired distinctiveness. However, since the anticipation intervals during the second step were relatively short, both repetition responses and correct vowel responses could not have readily occurred in sequence. And they could not occur simultaneously. Even though the former responses may have occurred with high frequencies during the early trials, in order for the task to be learned they probably had to be replaced by the vowel responses. It seems unlikely, therefore, that repetition responses were present in sufficient strengths to have affected fourth-step performance under Condition CI.

Repetition responses were also possible during the fourth step under Condition CII. Because the aural stimuli of the second step differed from those of the fourth step, repetition responses to the fourth-step stimuli would probably have been largely unaffected by second-step experiences under this condition. In view of the possible reductions in the strengths of repetition responses under Condition CI, any acquired distinctiveness and consequent facilitative effects based on such responses might well have been less under Condition CI than under Condition CII. Since these other possible bases of acquired distinctiveness were not possible or were not probable, it seems reasonable to conclude that the superiority of CI to CII during the fourth step was due to acquired distinctiveness of the aural stimuli based on stimuli produced by the experimentally-introduced vowel responses which had been conditioned to the aural stimuli during step two.

These results are of significance because they are among the relatively few demonstrations of positive transfer from prior experimental strengthening of discriminative verbal responses to initiating stimuli which can reasonably be attributed to such strengthening, and not to the simultaneous activation or strengthening of other responses (6). Further, except for Orlando's (17) inconclusive findings, these results are the only demonstration of experimentally-established response-mediated dissimilarity of aural rather than of visual stimuli.

<u>Effects of Strengths of Associations</u>

The second objective was to demonstrate that transfer from visual to aural stimuli would vary directly with strengths of associations between visual stimuli and verbal responses and between aural stimuli and verbal responses. Specifically, greatest facilitation was predicted for the Condition _E_ combination of high strengths of both sets of associations, while least facilitation was expected for the combination of low strengths of both sets of associations with the high-low and low-high combinations producing intermediate amounts of facilitation.

Under Condition _CI_, since acquired distinctiveness would have been based solely on strengths of associations between aural stimuli and verbal responses, the prediction was that only low and high strengths of those associations would be related to amount of positive transfer. Since the set of aural stimuli for step four under Condition CII differed from the set for step two, the expectation was that fourth-step performance under this condition would not be affected by combinations of association strengths.

Because of these differences among Conditions E, CI, and CII in expected effects of combinations of association strengths, some of the interactions involving conditions and strengths of associations between visual stimuli and verbal responses and between aural stimuli and verbal responses, both separately and together, might well have been significant statistically. None was, and, therefore, further statistical analyses which would have focused on more specific comparisons both within and between conditions and strengths of associations were not undertaken.

Examined qualitatively, it appeared that under Condition E, facilitation was obtained only with the high visual-high aural and low visual-high aural combinations of association strengths. Thus, only strengths of associations between aural stimuli and verbal responses may have influenced amount of intermodal transfer. Were this the case, the reason may be that differences between high and low strengths of associations between visual stimuli and the verbal responses were not marked and were considerably less than the differences between high and low strengths of associations between aural stimuli and the verbal responses.

Support for this suggestion comes from a comparison of the differences between trials through the 5/6 and 17/18 criteria for the former and for the latter associations. For the associations between visual stimuli and verbal responses, there were 12.2 trials through the 5/6 criterion and 30.8 trials through the 17/18 criterion, a difference of 18.6 trials which included the 12 additional trials of the 17/18 criterion. For the associations between aural stimuli and verbal responses, the difference between the 32.7 trials through the 5/6 criterion and the 93.8 trials through the 17/18 criterion was 61.1. The latter difference was greater than the former both absolutely and relative to number of trials through the 5/6 criterion.

Under Condition CI, the greatest amount of positive transfer was obtained with the low visual-high aural combination, and not with both this and the high visual-high aural combination. If the combined mean of these two combinations is taken as the more reliable estimate of the effects of high strengths of associations between aural stimuli and verbal responses, greater positive transfer was obtained, as predicted, with high than with low strengths of those associations.

The differences between means of correct responses for low and high strengths of associations between aural stimuli and vowel responses under Condition E was greater than that for Condition CI, and there was no difference under Condition

CI. However, the differences in these differences was not great enough to produce a significant interaction of conditions and strengths of associations between aural stimuli and verbal responses. Nor were the further differences in trends over the 36 trials sufficient to occasion a significant interaction of conditions, strengths of aural associations, and trials.

The results, therefore, suggest that only strengths of the associations between aural stimuli and verbal responses influenced the extent of positive transfer attributable to response-mediated generalization introduced by Condition E and to acquired distinctiveness introduced by Condition CI.

Summary

The first objective of this study was to determine the role of response-mediated generalization in the transfer of responses from one sensory modality to another. Common verbal responses to paired visual and aural stimuli were learned, after which different manipulative responses were conditioned to each visual stimulus and presumably to its accompanying verbal response-produced stimulus. These already-established associations between aural stimuli and verbal responses and between the stimuli produced by verbal responses and lever pushing were then expected to facilitate acquisition of different lever-pushing responses to the aural stimuli. One control condition provided a baseline for facilitation due to the acquired distinctiveness of cues and a second provided a baseline for positive transfer based on learning-performance sets.

The second objective was to ascertain whether amount of transfer of lever pushing from visual to aural stimuli varied with strengths of associations between visual stimuli and verbal responses and between aural stimuli and the same verbal responses.

The <u>S</u>s were 144 female undergraduates, each of whom learned successively: (a) vowel responses to nonsense forms, (b) those same vowel responses to aural Morse code signals, (c) lever-pushing responses to forms which were the same as

or different than those of the first step, and (d) lever-pushing responses to signals which were the same as or different than those of the second step. For the experimental condition, the visual stimuli of the first and third steps were the same, as were the aural stimuli of the second and fourth steps. For the control for acquired distinctiveness, the visual stimuli of the first step differed from those of the third but the aural stimuli of the second and fourth steps were the same. The visual stimuli of the first and third steps for the control for learning-performance set differed as did the aural stimuli of the second and fourth steps. Criteria of mastery of 5/6 and 17/18 correct responses defined two levels of strengths of associations between visual stimuli and vowel responses and between aural stimuli and those same responses.

Significantly more correct lever-pushing responses to aural stimuli were obtained with the experimental or response-mediated generalization condition than with the control for facilitation due to acquired distinctiveness of cues. While strengths of associations between the visual stimuli and the vowel responses did not affect extent of positive transfer, positive transfer may have occurred with high but not with low strengths of associations between aural stimuli and vowel responses.

The learning of lever-pushing responses to aural stimuli by the acquired-distinctiveness control was significantly faster than was that of the control for learning-performance set. Explanations of the superiority of the former condition involving responses other than the experimentally-introduced vowel responses were considered but ruled out. It was concluded that while response-mediated generalization based on associations between vowel response-produced stimuli and lever pushing had facilitated acquisition of lever-pushing responses to aural stimuli, acquired distinctiveness of those stimuli, due to stimuli produced by the experimentally-introduced vowel responses, was an additional and perhaps relatively more important source of positive transfer.

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Construction of Visual Stimuli

Figure	Coordinate Points	Order of Connections
List V		
(1)	3,7; 4,0; 1,3; 6,8; 9,7; 8,7; 6,4; 8,1; 0,7; 8,3.	1,3; 8,1; 9,7; 6,8; 0,7; 6,4; 8,7; 6,8; 8,3; 3,7; 6,4; 8,1; 8,3; 6,4; 6,8; 4,0; 3,7; 6,4; 8,3; 1,3.
(2)	2,5; 2,8; 9,9; 4,1; 2,7; 0,7; 4,1; 0,8; 3,4; 6,6.	6,6; 0,8; 2,8; 6,6; 9,9; 4,1; 6,6; 2,8; 0,8; 2,5; 2,8; 0,7; 3,4; 2,7
(3)	8,5; 1,3; 9,9; 2,4; 4,4; 4,9; 1,8; 0,9; 7,9; 4,9.	4,9; 1,3; 0,9; 1,8; 9,9; 4,9; 2,4; 4,9; 0,9; 2,4; 1,8; 7,9; 4,4; 8,5; 2,4.
List V'		
(4)	6,3; 9,6; 7,3; 7,6; 6,3; 8,9; 7,3; 4,4; 9,9; 0,5.	6,3; 7,3; 8,9; 9,6; 7,6; 4,4; 0,5; 6,3; 7,6; 9,9; 0,5.
(5)	1,1; 0,5; 9,2; 0,6; 9,7; 6,8; 8,2; 3,4; 0,8; 8,3.	9,2; 0,5; 8,3; 8,2; 1,1; 0,5; 9,7; 6,8; 0,5; 0,8; 9,7; 0,6; 8,3; 6,8; 0,6; 3,4; 8,3.
(6)	2,4; 1,6; 7,4; 1,1; 5,3; 4,4; 1,0; 1,3; 8,5; 5,7.	8,5; 2,4; 1,3; 1,6; 8,5; 1,0; 5,3; 1,1; 4,4; 1,0; 7,4; 1,1; 2,4; 4,4; 5,7; 1,1.

Instructions Administered in Tests to Determine Meaningfulness of Stimuli

Meaningfulness of Visual Stimuli

This is a test to see how many words you can think of and write down in 30 seconds with one important restriction.

The booklets in front of you contain a different figure on each page. Your task is to write on each page as many words in 30 seconds as the figure on that page brings to mind. These words may be things, places, ideas, events, or whatever you happen to think of when you look at the figure.

At the end of each 30 second period you will be told to stop writing and, after a short interval, to turn to the next page in the booklet. You may start on the next figure as soon as you turn the page.

No one is expected to fill the whole page for each figure. Some figures may bring to mind many associations, some only one or two, and some none. But write as many of the words that each figure brings to mind as you can.

Remember, the words you write are to be brought to mind by the figure on that page, not by the previously written words. A good procedure to follow is to repeatedly look at the figure while you write.

Are there any questions?

Meaningfulness of Aural Stimuli

This is a test to see how many words you can think of and write down in 30 seconds with one important restriction.

You will be presented, by tape recorder, with Morse code signals. Each signal will be presented at the beginning of a 30 second period and will be repeated several times throughout that interval. Your task is to write as many words as the signal brings to mind. These words may be things, places, ideas, events, or whatever you happen to think of when you hear the signal.

At the end of each 30 second period you will be told to stop writing and turn to the next page in the booklet in front of you. After a short interval the next signal will be presented throughout 30 seconds and you are to write the words that that signal brings to mind.

No one is expected to fill the whole page for each signal. Some signals may bring to mind many associations, some only one or two, and some none. But write as many of the words that each signal brings to mind as you can.

Remember, the words you write are to be brought to mind by the particular signal being presented, not by the previously written words. A good procedure to follow is to associate to each repetition of the signal as you write.

Are there any questions?

Counterbalancing

Table 11 shows how the two sets of visual stimuli and the two sets of code stimuli were counterbalanced within each of the four combinations of association strength under Conditions E, CI, and CII. V and V' designate the two sets of three form stimuli each; A and A' designate the two sets of three code stimuli each.

One-half of the Ss in each of the four combinations of association strength under Condition E learned verbal and motor responses to the forms of V; the other half learned those responses to the forms of V'. The Ss in these groups were further subdivided so that half of each first learned verbal and then motor responses to the code stimuli of A, while the other half first learned those responses to the code stimuli of A'.

For CI, half of the Ss within each of the four combinations of association strengths acquired verbal responses to the forms of V and motor responses to the forms of V'. The converse was true of the other half, with verbal responses being paired with the forms of V' and motor responses being paired with the forms of V. Half of the Ss of each group which was given the V and V' sequence learned verbal and then motor responses to the code stimuli of A; the other halves acquired those responses to the code stimuli of A'. Similarly, one-half of the Ss experiencing the V' and V sequence learned verbal and motor responses to the A stimuli while the code stimuli of A' were used for the other halves.

Half of the Ss within each of the four combinations of association strength of CII were given the V and V' forms as stimuli for verbal and motor responses, respectively; the other halves learned verbal responses to the V' forms and motor responses to the V forms. Within the halves experiencing the V and V' sequence and those given the V' and V sequence, Ss were further divided into three Ss who learned verbal responses to the A code stimuli and motor responses to the A' code stimuli, and three Ss for whom the A' stimuli were used for the verbal responses and the A stimuli for the motor responses. Thus, half of the Ss of each of the four combinations of association strengths under Conditions E, CI, and CII experienced the V or V' forms or the A or A' forms within each of the four steps. Any differences among conditions and combinations within conditions, therefore, should not have been due to the particular sets of form stimuli or code stimuli to which the verbal and motor responses were learned.

Table 11

Counterbalancing of the Two Sets of Visual Stimuli, V and V', and of the Two Sets of Aural Stimuli, A and A', for the Experimental and the Two Control Conditions

Condition	N	Visual Stimuli-Vowel Responses	Aural Stimuli-Vowel Responses	Visual Stimuli-Motor Choices	Aural Stimuli-Motor Choices
E	3	V	A	V	A
	3	V	A'	V	A'
	3	V'	A	V'	A
	3	V'	A'	V'	A'
CI	3	V	A	V'	A
	3	V	A'	V'	A'
	3	V'	A	V	A
	3	V'	A'	V	A'
CII	3	V	A	V'	A'
	3	V	A'	V'	A
	3	V'	A	V	A'
	3	V'	A'	V	A

Visual Stimuli: Their m-Value, Vowel Responses, and Lever-pushing Responses

Visual Stimuli*		Vowel Responses	Lever-pushing Responses
List V	m-Value		
1	1.31	e	90°
2	1.42	o	180°
3	1.77	u	240°
List V'	m-Value		
4	1.42	e	90°
5	1.15	o	180°
6	1.38	u	240°

Aural Stimuli: Their m-Value, Paired Vowel Responses, and Paired Lever-pushing Responses

Aural Stimuli*		Vowel Responses	Lever-pushing Responses
List A	m-Value		
-.-. (C)	.27	e	90°
...- (V)	.23	o	180°
-.. (D)	.27	u	240°
List A'	m-Value		
-..- (X)	.19	e	90°
--. (G)	.11	o	180°
..- (U)	.15	u	240°

* For figure representations see Appendix, Construction of Visual Stimuli

Instructions Administered on Successive Steps

Step I: Vowel Responses to Visual Stimuli

This is an experiment in learning materials and not a psychological test. We are interested in certain complex relationships of the learning process common to all people and are not concerned with your personal reactions.

When the task begins you will see a figure in the little window. After a few seconds the figure will disappear and a vowel letter will appear. Together the figure and vowel letter represent a pair. You will learn to associate the two so that when the figure appears you can call out the vowel before it is exposed. There will be several pairs which will not follow each other in any regular order. The figure and vowel of each pair, however, will always occur together.

An example would be the figure which would first occur, soon followed by the vowel "i". Your task will be to learn to call out "i" as soon as you see and before "i" actually appears.

When you see the figure, if you think you know what the vowel is, but are not sure, guess, because it will not hurt your score any more than to say nothing, and if you get it right, it will count as a success. If you are not correct in your response, say the correct vowel when it appears.

Remember, as the figure is presented call out the vowel before it is exposed. If you are wrong, say the correct response.

Do you have any questions?

Step II: Vowel Responses to Aural Stimuli

This is the second part of the experiment.

When the task begins the taped recording will start and you will hear a code signal. After a few seconds a vowel sound will be heard. Together the code signal and the vowel sound represent a pair. You will learn to associate the two so that when the code signal is given on the tape you can call out the vowel sound before it is given. There will be several pairs which will not follow each other in any regular order. The code signal and vowel sound of each pair, however, will <u>always occur together</u>.

An example would be the code signal "da-da-da" which would first occur, soon followed by the vowel sound "i." Your task will be to learn to call out "i" as soon as you hear "da-da-da" and before "i" actually is heard.

When you hear the code signal, if you think you know what the vowel sound is, but are not sure, guess, because it will not hurt your score any more than to say nothing, and if you get it right, it will count as a success. If you are not correct in your response, <u>say</u> the correct vowel when it is heard.

Remember, as the code signal is presented call out the vowel <u>before</u> it is given. If you are wrong, say the correct response.

Do you have any questions?

<u>Step III: Lever-Pushing to Visual Stimuli</u>

This is the third part of the experiment.

On the box in front of you there is a lever and bulb. The lever can be moved in three directions: right, left, and forward. When the task begins you will see a figure in the little window. You are to learn the correct lever-pushing direction for that figure. If you have made the correct response, the light in back of the lever will go on, and if you have pushed the lever in the wrong direction the light will remain off. There will be several figures which will not follow each other in any regular order. However, there is only <u>one</u> correct direction for each figure.

An example would be the figure which would first occur. The correct lever-pushing direction for that figure might be "left." Your task is to learn to push the lever to the "left" every time you see . When you select the correct direction (in our example, "left"), the light will go on. If you select the wrong direction (in our example, "right" or "forward"), the light will remain off.

You are to push the lever only <u>once</u> for each presentation of a figure. If you have selected the wrong direction, you must wait until the next presentation of that figure to try another direction. Again, you have only one push permitted per presentation of a figure.

The light only indicates whether you are correct or incorrect after you have pushed the lever. Since it does not come on before you respond you must respond each time a figure occurs if you are to learn the correct direction for that figure.

Remember:

(a) The light will go on if you have pushed the lever in the correct direction and remain off if your selection is wrong.

(b) Only push the lever once per figure. Push it as far as it will go and return it to the "S" position after you respond.

(c) You must respond to one figure before the next figure is presented.

Step IV: Lever Pushing to Aural Stimuli

This is the fourth part of the experiment.

On the box in front of you there is a lever and bulb. The lever can be moved in three directions; right, left, and forward. When the task begins the tape recorder will start and you will hear a code signal. You are to learn the correct lever-pushing direction for that code signal. If you have made the correct response, the light in back of the lever will go on, and if you have pushed the lever in the wrong direction the light will remain off. There will be several code signals which will not follow each other in any regular order. However, there is only one correct direction for each code signal.

An example would be the signal "da-da-da" which would first be heard. The correct lever-pushing direction for that signal might be "left." Your task is to learn to push the lever to the "left" every time you hear "da-da-da." When you select the correct direction (in our example, "left"), the light will go on. If you select the wrong direction (in our example, "right" or "forward"), the light will remain off.

You are to push the lever only once for each presentation of a code signal. If you have selected the wrong direction, you must wait until the next presentation of that code signal to try another direction. Again, you have only one push permitted per presentation of a code signal.

The light only indicates whether you are correct or incorrect after you have pushed the lever. Since it does not come on before you respond, you must respond each time a signal is heard if you are to learn the correct direction for that code signal.

Remember:

(a) The light will go on if you have pushed the lever in the correct direction and remain off if your selection is wrong.

(b) Only push the lever once per signal. Push it as far as it will go and return it to the "S" position after you respond.

(c) You must respond to one signal before the next signal is presented.

Do you have any questions?

Trials through Criterion in Steps I, II, and III for each S for Combinations of Association Strengths and for Sets of Stimuli with the E, CI, and CII Conditions

Condition	Combinations of Association Strengths and Sets of Stimuli in Steps I and II*	Sets of Stimuli in Step III	Subject	Step I	Step II	Step III
E						
	HV -HA	V	1	28	117	30
			2	20	24	21
			3	36	115	21
	HV'-HA	V'	4	22	89	17
			5	23	122	18
			6	32	74	27
	HV -HA'	V	7	40	150	25
			8	21	96	17
			9	32	192	17
	HV'-HA'	V'	10	41	86	17
			11	26	37	20
			12	42	56	23

* HV = high strength of associations between Set V visual stimuli and vowel responses
HV' = high strength of associations between Set V' visual stimuli and vowel responses
LV = low strength of associations between Set V visual stimuli and vowel responses
LV' = low strength of associations between Set V' visual stimuli and vowel responses
HA = high strength of associations between Set A aural stimuli and vowel responses
HA' = high strength of associations between Set A' aural stimuli and vowel responses
LA = low strength of associations between Set A aural stimuli and vowel responses
LA' = low strength of association between Set A' aural stimuli and vowel responses

Trials through Criterion in Steps I, II, and III (continued)

Condition	Combinations of Association Strengths and Sets of Stimuli in Steps I and II	Sets of Stimuli in Step III	Subject	Step I	Step II	Step III
	HV -LA	V	13	36	64	21
			14	23	15	38
			15	20	14	18
	HV'-LA	V'	16	40	24	20
			17	62	44	22
			18	36	38	18
	HV -LA'	V	19	45	34	19
			20	49	13	20
			21	54	8	23
	HV'-LA'	V'	22	42	18	31
			23	37	23	18
			24	33	20	19
	LV -HA	V	25	9	53	30
			26	9	88	19
			27	10	124	17
	LV'-HA	V'	28	11	58	27
			29	25	99	17
			30	9	31	18
	LV -HA'	V	31	10	71	23
			32	13	70	19
			33	11	82	23
	LV'-HA'	V'	34	17	201	31
			35	11	93	19
			36	8	185	19
	LV -LA	V	37	12	37	19
			38	12	51	39
			39	9	8	17
	LV'-LA	V'	40	10	11	21
			41	8	70	36
			42	24	26	45
	LV -LA'	V	43	9	27	18
			44	11	25	17
			45	10	27	22
	LV'-LA'	V'	46	8	20	18
			47	9	11	20
			48	12	38	59

Trials through Criterion in Steps I, II, and III (continued)

Condition	Combinations of Association Strengths and Sets of Stimuli in Steps I and II	Sets of Stimuli in Step III	Subject	Step I	Step II	Step III
CI						
	HV -HA	V'	49	37	104	21
			50	21	86	17
			51	24	42	17
	HV'-HA	V	52	24	106	24
			53	32	126	23
			54	43	186	22
	HV -HA'	V'	55	21	26	27
			56	20	131	17
			57	23	60	27
	HV'-HA'	V	58	36	69	27
			59	28	130	21
			60	21	30	19
	HV -LA	V'	61	21	15	24
			62	20	22	18
			63	36	17	17
	HV'-LA	V	64	24	11	23
			65	24	9	26
			66	20	26	43
	HV -LA'	V'	67	54	56	18
			68	44	15	28
			69	21	40	23
	HV'-LA'	V	70	23	38	20
			71	21	7	17
			72	21	57	19
	LV -HA	V'	73	8	89	20
			74	14	45	22
			75	54	63	19
	LV'-HA	V	76	11	95	18
			77	14	124	17
			78	9	83	18
	LV -HA'	V'	79	9	39	19
			80	18	146	18
			81	8	78	17
	LV'-HA'	V	82	9	59	21
			83	12	146	25
			84	14	50	26

Trials through Criterion in Steps I, II, and III (continued)

Condition	Combinations of Association Strengths and Sets of Stimuli in Steps I and II	Sets of Stimuli in Step III	Subject	Step I	Step II	Step III
	LV -LA	V'	85	12	40	24
			86	8	63	18
			87	13	139	25
	LV'-LA	V	88	24	17	36
			89	11	30	25
			90	11	71	31
	LV -LA'	V'	91	14	53	64
			92	9	24	31
			93	8	30	34
	LV'-LA'	V	94	9	24	39
			95	10	54	21
			96	16	48	34
CII						
	HV -HA	V'	97	22	94	31
			98	32	81	17
			99	23	75	25
	HV'-HA	V	100	24	148	20
			101	29	45	19
			102	36	153	97
	HV -HA'	V'	103	40	75	86
			104	55	106	36
			105	26	78	21
	HV'-HA'	V	106	26	37	23
			107	23	22	18
			108	21	70	22
	HV -LA	V'	109	20	14	21
			110	24	11	21
			111	24	31	25
	HV'-LA	V	112	32	16	18
			113	22	33	18
			114	31	23	17
	HV -LA'	V'	115	37	8	44
			116	38	32	22
			117	40	17	21
	HV'-LA'	V	118	40	16	41
			119	32	23	24
			120	22	21	24

Trials through Criterion in Steps I, II, and III (continued)

Condition	Combinations of Association Strengths and Sets of Stimuli in Steps I and II	Sets of Stimuli in Step III	Subject	Step I	Step II	Step III
	LV -HA	V'	121	12	203	25
			122	13	153	22
			123	9	122	19
	LV'-HA	V	124	9	90	19
			125	11	128	24
			126	18	58	17
	LV -HA'	V'	127	14	107	56
			128	8	26	22
			129	11	150	50
	LV'-HA'	V	130	15	96	36
			131	11	150	55
			132	16	27	17
	LV -LA	V'	133	13	10	25
			134	8	17	29
			135	9	9	45
	LV'-LA	V	136	8	42	17
			137	10	44	17
			138	8	143	41
	LV -LA'	V'	139	14	63	21
			140	10	66	26
			141	9	56	17
	LV'-LA'	V	142	16	13	18
			143	8	39	20
			144	16	34	23

Numbers of Correct Responses in Successive Blocks of Trials and Total Trials in Step IV for Combinations of Association Strengths with the E, CI, and CII Conditions

Condition	Combinations of Association Strengths*	Subject	Block of Trials 1	2	3	4	5	6	Total
E									
	HV-HA	1	5	6	5	5	6	5	32
		2	4	6	6	6	6	6	34
		3	1	5	5	6	6	6	29
		4	6	6	4	6	6	6	34
		5	4	2	2	3	0	0	11
		6	1	3	5	4	6	3	22
		7	0	6	4	6	6	6	28
		8	4	5	6	6	6	6	33
		9	3	5	6	6	6	5	31
		10	4	4	4	6	6	5	29
		11	5	6	6	6	6	6	35
		12	4	4	5	5	6	3	27
	HV-LA	13	2	6	6	6	6	6	32
		14	1	2	4	4	4	4	19
		15	4	4	3	3	3	6	23
		16	2	1	0	3	2	4	12
		17	3	5	4	6	5	5	28
		18	3	6	5	5	6	5	30
		19	1	2	2	1	3	3	12
		20	3	0	0	4	5	4	16
		21	5	3	5	5	6	5	29
		22	6	5	6	6	5	6	34
		23	4	3	2	2	1	6	18
		24	5	2	5	5	6	6	29

* HV = high strength of associations between visual stimuli and vowel responses
LV = low strength of associations between visual stimuli and vowel responses
HA = high strength of associations between aural stimuli and vowel responses
LA = low strength of associations between aural stimuli and vowel responses

Numbers of Correct Responses in Step IV (continued)

Condition	Combinations of Association Strengths	Subject	Block of Trials 1	2	3	4	5	6	Total
	LV-HA	25	3	5	5	5	6	5	29
		26	5	5	6	5	6	6	33
		27	4	6	5	6	6	6	33
		28	5	4	6	4	6	6	31
		29	2	4	2	3	3	4	18
		30	5	6	6	6	6	5	34
		31	4	6	6	6	6	6	34
		32	1	4	1	5	6	6	23
		33	0	3	5	6	6	6	26
		34	4	6	6	5	4	5	30
		35	5	6	6	6	6	6	35
		36	4	5	6	6	6	5	32
	LV-LA	37	1	1	5	2	2	4	15
		38	4	4	5	6	6	5	30
		39	0	4	6	6	6	6	28
		40	2	3	3	4	2	5	19
		41	4	2	4	4	5	6	25
		42	4	5	5	4	4	4	26
		43	1	3	5	3	4	5	21
		44	4	4	5	5	6	6	30
		45	2	5	4	6	6	6	29
		46	5	6	6	6	5	6	34
		47	4	3	4	1	4	3	19
		48	2	3	4	5	3	6	23
<u>CI</u>									
	HV-HA	49	1	3	2	4	1	0	11
		50	3	5	5	6	6	6	31
		51	1	1	3	0	2	1	8
		52	5	5	4	6	5	5	30
		53	4	2	4	2	6	5	23
		54	2	5	6	6	5	6	30
		55	1	2	6	6	6	6	27
		56	3	2	2	1	4	3	15
		57	5	6	6	6	6	6	35
		58	3	4	5	6	5	6	29
		59	2	6	6	5	6	6	31
		60	0	2	6	4	5	3	20

Numbers of Correct Responses in Step IV (continued)

Condition	Combinations of Association Strengths	Subject	Block of Trials 1	2	3	4	5	6	Total
	HV-LA	61	2	5	5	5	5	6	28
		62	3	6	5	6	6	6	32
		63	4	6	5	4	4	5	28
		64	2	3	1	1	4	4	15
		65	4	1	2	3	1	5	16
		66	0	2	5	3	6	6	22
		67	1	1	4	4	3	4	17
		68	4	3	6	5	5	6	29
		69	5	1	3	5	1	4	19
		70	5	6	6	5	6	5	33
		71	5	6	6	6	5	6	34
		72	3	3	5	6	5	6	28
	LV-HA	73	5	5	6	5	6	6	33
		74	1	5	5	6	6	6	29
		75	1	6	6	6	6	6	31
		76	6	6	6	6	6	6	36
		77	1	5	6	5	6	6	29
		78	4	6	6	6	6	6	34
		79	1	3	5	6	6	6	27
		80	3	3	3	5	6	4	24
		81	4	3	6	6	6	6	31
		82	6	6	5	6	6	6	35
		83	1	4	3	4	4	6	22
		84	4	5	5	5	4	6	29
	LV-LA	85	4	3	4	5	5	4	25
		86	2	3	5	3	4	4	21
		87	1	4	2	3	3	3	16
		88	2	1	4	1	3	2	13
		89	3	3	3	2	4	2	17
		90	2	3	4	5	6	6	26
		91	3	2	5	6	6	5	27
		92	6	4	4	5	5	5	29
		93	4	4	5	6	6	5	30
		94	1	0	5	4	4	6	20
		95	6	6	4	6	6	5	33
		96	4	3	4	5	6	6	28

Numbers of Correct Responses in Step IV (continued)

Condition	Combinations of Association Strengths	Subject	Block of Trials 1	2	3	4	5	6	Total
CII									
	HV-HA	97	2	4	5	5	6	6	28
		98	4	6	4	5	4	5	28
		99	5	6	6	6	6	6	35
		100	1	1	3	2	1	3	11
		101	5	4	6	3	5	5	28
		102	0	2	4	3	3	2	14
		103	3	6	6	4	4	4	27
		104	2	5	3	3	2	0	15
		105	5	5	6	4	5	5	30
		106	1	4	2	2	4	5	18
		107	4	6	4	6	5	6	31
		108	3	4	6	4	6	6	29
	HV-LA	109	4	5	6	6	6	6	33
		110	5	6	5	6	5	5	32
		111	3	5	6	5	6	5	30
		112	2	4	4	3	5	4	22
		113	5	6	5	4	5	6	31
		114	1	2	6	6	6	6	27
		115	1	2	3	5	3	4	18
		116	5	3	0	3	5	2	18
		117	2	4	4	3	5	5	23
		118	4	3	3	5	1	4	20
		119	1	2	3	1	3	5	15
		120	4	6	4	4	5	3	26
	LV-HA	121	2	3	1	3	3	3	15
		122	4	3	4	4	3	4	22
		123	5	4	4	4	2	2	21
		124	5	4	3	6	5	6	29
		125	4	4	3	3	5	4	23
		126	1	5	6	6	4	6	28
		127	1	3	2	5	2	2	15
		128	1	2	4	6	5	6	24
		129	3	1	2	5	4	4	19
		130	4	6	6	6	5	6	33
		131	2	0	0	3	4	5	14
		132	2	4	6	5	6	6	29

Numbers of Correct Responses in Step IV (continued)

Condition	Combinations of Association Strengths	Subject	Block of Trials 1	2	3	4	5	6	Total
		133	1	3	5	5	5	5	24
		134	2	0	0	1	6	6	15
		135	3	1	3	3	6	3	19
		136	4	4	5	6	5	5	29
		137	6	6	5	6	3	6	32
		138	1	3	2	4	3	2	15
	LV-LA	139	0	2	3	4	3	3	15
		140	3	3	3	4	6	5	24
		141	2	3	3	2	4	4	18
		142	2	4	4	3	3	5	21
		143	2	5	3	2	3	6	21
		144	3	4	4	4	4	6	25

ACKNOWLEDGMENTS

Sincere gratitude is extended to Dr. Albert E. Goss for aid in the development of theoretical formulations crucial to the initiation of this study and for guidance through its completion.

Gratitude is also extended to the following people: (a) Drs. Claude C. Neet, Robert S. Feldman, and James B. Ludtke for important suggestions in the initial stages of the study and for aid in the revision of the manuscript; (b) Drs. Jerome L. Myers, Warren H. Teichner, and David W. Lewit, Mrs. Mary E. W. Goss, and Mrs. Barbara S. Musgrave for critically reading the manuscript and making suggestions that aided in its revision; and (c) Mr. Alan H. Leiman and Mrs. Francine B. Lifton for assistance in the preparation of the test materials and Mr. Joseph Mach for the solution of apparatus problems.

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Date: January 6, 1959.